

# THREE DIMENSIONAL ANALYSIS OF THE CLEAN AND JERK TECHNIQUES FOR FEMALE ELITE CHINESE WEIGHTLIFTERS

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## INTRODUCTION

Interest in female weightlifting has increased in recent years. The First World Women's Weightlifting Championship was held in Florida with nine weight categories. At this meet, 27 world records of snatch, clean and jerk, and total weight were set. Chinese weightlifters took part in eight weight categories and set 22 world records. They have been prominent at the World Championships every year since. At the 6th World Women's Weightlifting Championship in Bulgaria in 1992, Chinese weightlifters broke 24 world records and had 26 champions. In this study, the techniques of Chinese elite female weightlifters were analyzed in order to promote their technical levels of weightlifting.

## METHODOLOGY

Nine Chinese female weightlifters who took part in weightlifting at the 1990 Asian Games in Beijing were studied. Subject characteristics are presented in Table 1. The subjects included nine champions in the snatch, clean and jerk, and total weight lifted in nine weight categories. Seven set world records and one was the champion of the World Championship.

The data for this study were collected during the female weightlifting matches of 1990 Asian Games from September 23 to 25. The technical films of snatch, clean and jerk were taken by two synchronized high speed cameras (PHOTO-SONICS 1PL16MM) set 20m apart from the center of platform. Camera A was set at the right-front of platform and camera B at left-front. The angle of primary optical axis of two cameras was 85° and the vertical distance of lens from the surface of platform was 1.1 m. The photographic frequency was 48.2 fps.

Table 1. Subject characteristics of the weightlifters.

Name	Height (m)	Mass (kg)	Mass Lifted (kg)	Remarks
Xing Fen	1.47	44	95.0	
Huang Xiaoyu	1.52	48	95.0	World record
Peng Liping	1.47	52	107.5	holders of snatch,
Guo Qiuixiang	1.61	67.5	115.0	clean and jerk, and total.
Li Hongling	1.67	82.5	130.0	
Han Changmei	1.67	82.5 (+)	132.5	
Ma Na	1.52	60	115.0	World record holder
Xing Liwei	1.56	56	105.5	World Champion
Shi Wen	1.61	75	125.0	

The technical films were digitized by TYF-2 analytical photo-grammeter. The digitized data were converted into three dimensional coordinates using the direct linear

transformation (DLT) method and smoothed by lowpass filtering method. Finally the displacement and velocity of gravity center of bar and body, the angular displacement and velocity of main joints of body were calculated.

The clean and jerk consists of a squat clean (clean the weight to the chest) and a jerk. Using the vertical velocity curve of center of gravity of the bar and the pattern of exertion, the squat clean portion of the lift can be divided into five phases: A. get set; B. pull bar (pull bar to knees); C. explosive pull; D. inertial going up; and E. prop up the bar. These are illustrated in Figure 1. The jerk portion of the lift also can be divided into five phases: H. down squat; I. braking; J. explosive jerk; K. inertial going up; and L. prop up the bar. These are illustrated in Figure 2.

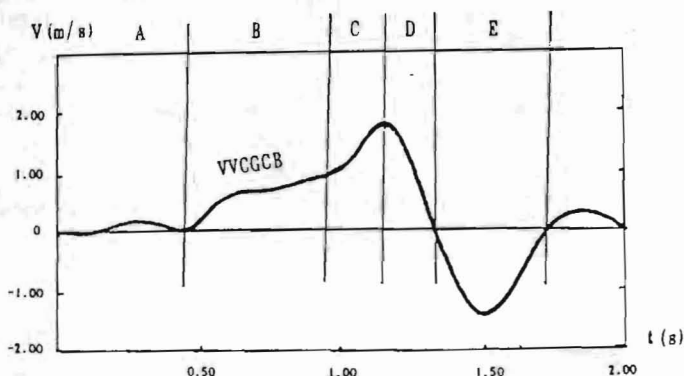


Figure 1. Division of squat clean phase using the vertical velocity curve of the center of gravity of the bar. A. get set; B. pull bar; C. explosive pull; D. inertial going up; and E. prop up the bar.

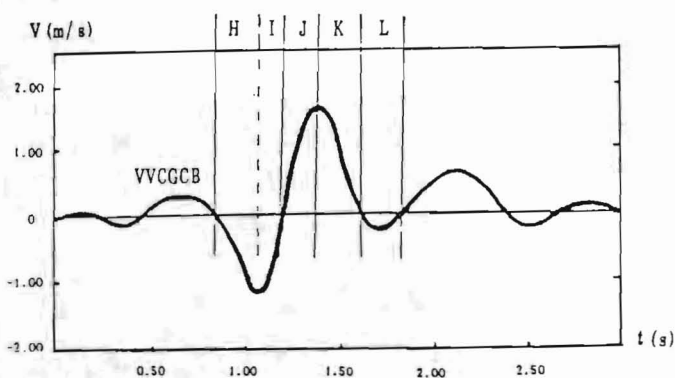


Figure 2. Division of jerk lift into phases using the vertical velocity curve of the center of gravity of the bar: H. down squat; I. braking; J. explosive jerk; K. inertial going up; and L. prop up the bar.

## RESULTS and DISCUSSION

### Duration of each phase

The explosive pull of the nine female weightlifters, lasting 0.17 s, was shorter than that of 11 male weightlifters of Chinese National Team (0.24 s). The duration of explosive jerk in female weightlifters (0.19 s) was also shorter than that of 10 male

weightlifters (0.23 s) at '90 Asian Games. The cause of the shorter explosive pull and explosive jerk was related to the difference in body proportions. For example, the mean height was of the females was  $1.56 \pm 0.07$  m and  $1.65 \pm 0.11$  m for the males.

#### Vertical displacement of gravity center of bar

The center of the bar was raised a total of 0.78 m in three phases of pull bar. It was dropped back 0.34 m in prop up the bar phase of squat clean. Shi Wen raised the bar the least (0.69 m) and dropped it (0.24 m) and exhibited a good technique. Xing Liwei and Huang Xiaoyu raised the bar the highest (0.86 m) and dropped it (0.43 m) exhibiting poorer techniques. The dropping distance of bar during explosive jerk females was longer (0.06 m) in the females than that in males (0.03 m) indicating that the technique of the females remains to be improved.

#### Vertical velocity of gravity center of bar

The greatest velocity of bar in the explosive pull phase for females was  $1.57 \pm 0.17$  m/s which was close to the results ( $1.59 \pm 0.01$  m/s) of seven champions (including six Chinese) at the 1st World Women's Championship reported by Garhammer (1991). The velocity of the bar during the initial knee bend phase was greater for the females (-0.96 m/s) than that in males (-0.87 m/s) indicating a faster knee bend in females.

#### Vertical velocity of gravity center of body

The velocity in the initial knee bend and explosive jerk phases in females was higher (-0.66 m/s and 0.99 m/s, respectively) than that in males (-0.45 m/s and 0.84 m/s, respectively) demonstrating the better technique of the females. The velocity in the phase of explosive jerk (0.76 m/s) was higher than that in explosive pull (0.67 m/s). The maximum acceleration of dropping of the center of gravity of the body was  $-14.8$  m/s<sup>2</sup> in the squat clean phase and  $-13.7$  m/s<sup>2</sup> in the jerk phase both of which were greater than the acceleration of gravity(*g*).

#### Angles of knee joints in the beginning and the end of explosive pull and jerk

The angles of the beginning and the end of the explosive pull in females were 124.6° and 155.6°, respectively and in explosive jerk they were 111.5° and 162.5° respectively. The optimum angles at the beginning of the explosive pull and the explosive jerk depended not only on the functional status of the muscle groups of the knee joint itself but were also related closely to the whole body posture and total weight load.

## CONCLUSIONS

The main technical defects of clean and jerk of Chinese female weightlifters compared to the technique of male weightlifters were found to be the relatively greater distances of bar raising and dropping. This produced a greater proportion of useless work, indicating a great potential for technical improvement in females. The velocities of initial knee bend and jerk were greater in females than that in males, and thus female weightlifters performed proportionately better. The optimum angle of the beginning of the explosive pull and the explosive jerk and the resulting extending angle were not only dependent on the functional status of muscle groups of the knee joint itself, but were also related closely to body posture and total weight load.

## REFERENCES

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